



TGW STINGRAY SHUTTLE STORAGE SYSTEM

High performance Warehouse

TGW is a market leader in turn-key systems. Essential knowledge to provide performant solutions across all levels (WMS, MFR, Controls, Mechanics, Steelworks), adaptable to merge with customer layers. Proven standard systems cover the range -30°C to 40°C (-22°F to 104°F), with advanced steelworks architecture enabling 'Clad rack' structures. High upfront planning accuracy increases system quality and minimizes engineering lead-time.

Stingray shuttle systems are the perfect 'melting pot' of benefits. Occupying the maximum storage density for the footprint available, with extremely high system performances on highly energy efficient components, where redundancy is systemic in the design. With over 13,000 Stingray shuttles sold, these are proven standard solutions ranging from ambient to freezer applications, robust operation even in extreme conditions such as earthquake zones. A landscape of opportunities to a customer's business, offering longterm operational security with high system availability.

EXTREMELY HIGH STORAGE DENSITY & PERFORMANCE

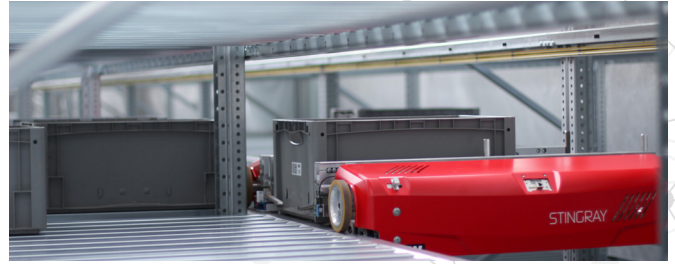
The Stingray shuttle system is world-class when it comes to performance and redundancy. High system flexibility from an extensive standardized product portfolio which is configurable to specific customer requirements used in different areas in a Fulfilment Centre, such as order picking, consolidation and sequencing.



Storage capacity:

- Frontal or Central connections, which are flexible to the customer application. Keeping shuttle distances to a minimal, and utilizing all storage capacity, scalable to 150m long x 30m (492' x 98.4') high
- Direct carton handling, totes & trays, with a 50kg (110lbs) shuttle payload
- Choice of Shuttles to match load carrier dimension from 150×200×50mm to 860×660×600mm (5.9"×7.9"×2" to 34"×26"×23.6"):
 - Fixed telescope 'N' variant covers applications with a single load carrier width. Accommodating single load carrier dimensions, or load carriers with identical widths e.g. 600×400 lengthwise and 400×300 crosswise
 - Variable telescope 'V' shuttle for mixed load carriers, 560mm (22") telescope width delta

- Storage capacity vs. Performance driven applications: the WA variant extends the aisle clearance from 1050mm to 1600mm (41.3" to 63") enabling more storage depth, e.g. 650mm (25.6") cartons increases from 2 to 3 deep, maximizing storage density for the available footprint. WA is available in both 'N' & 'V' variants
- Pattern types represent different virtual load carrier dimensions in multi-deep (1-6) configurations. Each shelf can dynamically assign patterns to exploit the maximum storage density, smaller load carriers can always be placed in larger patterns. Width Classes can be modified in operation, changing to match the current load carrier types
- 2 LHDs possible on both the Tote and Shuttle lift, maximises each lift performance capability
- Fully equipped with a Stingray on each level, or partially equipped with fewer shuttles using the shuttle lift to access all levels. Balancing performance, system length/depth/height, cost, SKU count. Fully equipped would provide the maximum performance, partially equipped reduces the cost. The bottle neck on high systems can be the tote lift, in this case partially equipped reduces system cost without affecting performance
- Shuttles can be added to a system to increase performance in the existing installation. The system is scalable and easily evolves with the customer's business diversity

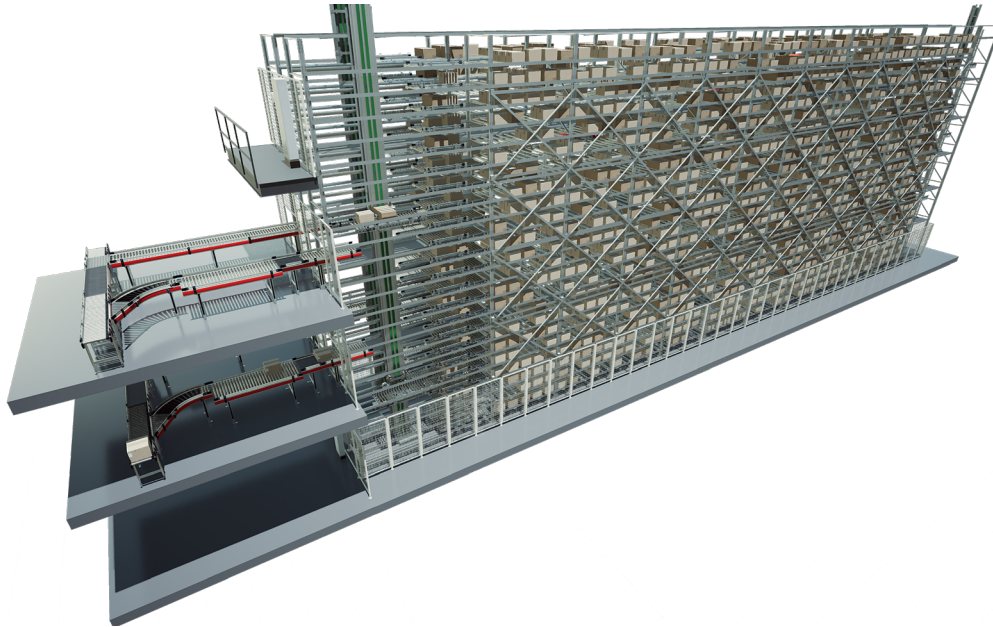


PERFORMANCE UP TO 1400 LOAD CARRIER PER AISLE PER HOUR

- All wheel drive and self-correcting encoder positioning system gives extraordinary shuttle positioning accuracy at the maximum speed and acceleration values (4m/s, 2m/s² - 787FPM, 6.6ft/s²)
- Fast and reliable patented 3-pair finger system positively engages to push/pull the load carrier during transfers
- Low shuttle weight (60kg, 132 lbs) provides efficient and fast movements. Shuttles do not use batteries, significantly reducing weight, increasing performance, increasing efficiency, simplifying the safety concept, and reducing maintenance costs considerably
- Single or Double carriage lifts (TLS/TLD, SLS/SLD). Lifts can be chosen with one or two LHD. The double LHD has the highest possible performance where each LHD works completely independent of the other, the only restriction is that the two cannot pass each other. The innovative control system reacts to each LHD and guarantees safe operation. Depending on the storage strategy, connection concept, segmentation, material flow concept, and sequencing requirements, up to twice the performance of a single carriage lift can be achieved.
- Our product portfolio is flexible to customer adaptations to achieve the optimum solution. For example Stingray Shuttle Systems can be configured with Single or Dual Cycle Lifts in Frontal or Lateral connections, as well as applying just one tote lift to an aisle; steering the focus depending on key customer requirements of performance, cost, and availability/redundancy



One choice affects the other, **'System simulation'** ensures the system performs as expected, proving which strategies guarantee the optimal system behaviour to the customer. **'Emulation software'** replicates the designed system control and physical behaviour before it is built. IT logistics software can connect and control the emulated shuttle system via exactly the same interfaces, proving the whole FC.



ENERGY EFFICIENCY

Through performance efficiency and energy recovery the Stingray system has multiple mechanisms achieving a green energy responsibility. Design speed and acceleration are balanced with system performance for the most efficient operation. Independently each element recovers all available braking energy, which is combined in a system bringing the maximum energy efficiency.

- PowerCaps on each maintenance level store the energy recovered from each Shuttle, which is then used to accelerate other shuttles on the same maintenance level
- The tote and shuttle lifts recover energy which is first used to power the other lifts in the same aisle, excessive energy is distributed into the PowerCaps on each maintenance level
- Excessive energy not needed by the system is fed back into the network. A ratio of around 50% of recovered energy is fed back into the network

The Patented 'PowerCaps' have additional benefits:

- Stored energy smooths the system peak energy demands, 'Peak Shaving' reduces the maximum load requirements and transformer size by 35%. Energy efficient and cost reducing
- Power failures are effectively handled, the stored energy brings each shuttle to a controlled stop



MAINTENANCE & RELIABILITY

High availability of the system relies on effective maintenance processes that allow continued operations when maintenance access is needed.

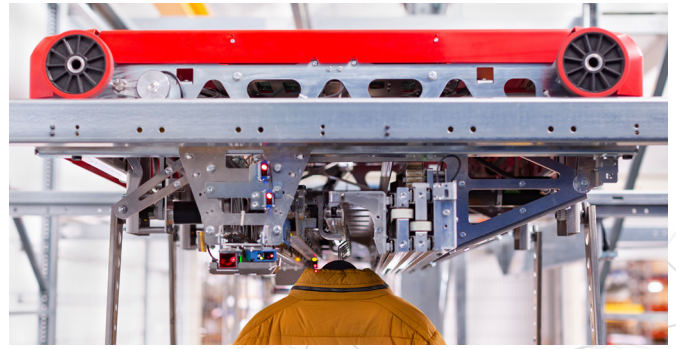
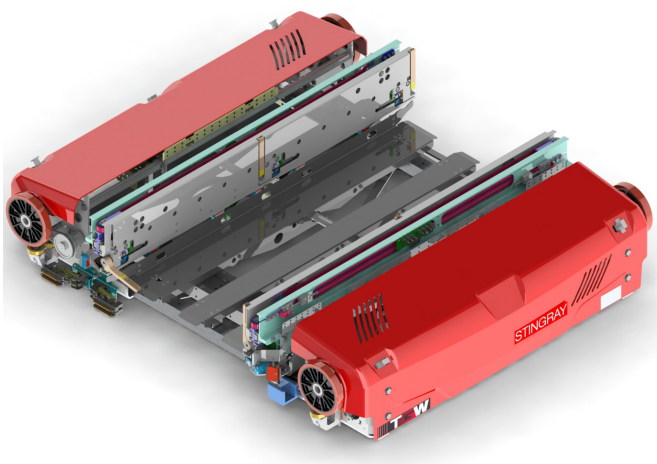
Like every car that clocks up the kilometres or miles, each Stingray shuttle also needs to be serviced.

- The automated shuttle lift is operated by one person to manoeuvre each shuttle in/out of the operational system without entering the aisle or affecting system availability. Cost optimized manual lifts are also available, requiring two people operation
- Associated equipment handles Stingray shuttle maintenance with ease: Maintenance cart, Transport cart, Lift cart, Maintenance storage rack
- The Shuttle service station provides optimal maintenance operation. A small rack with controls hardware & software which provides extensive testing & diagnostics. The Stingray Controls Manager (SCM) performs predefined test cycles, on all drives, sensors, and functions. Documented protocol results are generated, with only fully functional Shuttles being reintroduced into the system

MAINTENANCE ACCESS

- The storage system is fenced for protection
- Maintenance level access (approx. every 2.5m, 8.2') only affects certain shuttles levels (max. 8 levels), most of the system remains active. With an operator panel per maintenance aisle
- Safety light grids protect the operator whilst inside the aisle, and allow for the tote lift to continue operation. This allows for most of the aisle to continue, except for the accessed maintenance level
- All maintenance activities are carried out from the maintenance levels; resulting in very safe, fast and efficient maintenance throughout the lifetime of the system
- When the aisle is accessed, power to the affected Shuttle levels switches from 60v to 24v. The shuttle motor can no longer operate but the controls and sensors remain active, allowing for full diagnostics and provides the shortest possible shuttle restart time, minimizing operational impact

SAV (SCADA & HMI) with mobile tablet access implements a very effective Maintenance tool. Current status, diagnostic and camera information provides fast problem recognition, which reduces intervention time to a minimum and avoids unnecessary journeys. Controls communication to the shuttle is executed over the power line (**PLAN**), offering high levels of security and is extremely reliable in a steel structure (especially compared to WiFi).



TOTAL COST OF OWNERSHIP

- Flexibility of the standardized equipment, facilitates the maximum storage density, in configurations that balance performance and cost
- Partially or fully equipped systems maximize the best Performance / Storage density / Cost ratio
- Directly handling of cartons reduces process steps, removing additional equipment such as trays
- Energy efficiency & recovery reduce operational cost, and positively impact green energy initiatives
- Energy efficiency and PowerCaps reduce energy installation requirements with network and transformer sizing (reduced by 35%)
- Lift choices balance cost/performance/redundancy: one or two tote lifts per aisle, single or double gondola, single or dual cycle
- LHD and level conveyors use the successful KingDrive® technology, adopting its success and benefits providing operational security through high reliability and long product lifespan
- Pre-constructed equipment is 100% tested by TGW, ensuring onsite quality and efficient commissioning (Stingray shuttles, Tote lifts, Shuttle lifts and Level conveyors)
- 70% parts commonality between the Tote and Shuttle lifts reduces the spare parts package significantly (~50%).